REMARKS/ARGUMENTS

The following remarks are made in response to the Examiner's Action mailed January 13, 2010.

STATUS OF THE CLAIMS

Applicant notes that the Examiner entered the amendments submitted on November 12, 2009 and that currently there are pending in the application, claims 1, 3, 6, 8-14 and 22-25.

Applicant notes the Examiner's summary of the telephone interview which took place on December 14, 2009 and wishes to acknowledge and thank the Examiner and his supervisor for this interview.

Applicant notes that the previous 35 USC 112 rejection, second paragraph, of claim 1 has been withdrawn in light of the amendments made to claim 1 previously.

The Examiner has also indicated that the previous 35 USC 112 rejection, second paragraph, of claim 20 is moot because the claim was cancelled.

Applicant finally notes that all previous 35 USC 103(a) rejections of claims 1-3, 6-14, 19, 21 and 22 over Smiljanic et al. (*Chem. Phys. Lett.*, 356, 2002, 189-193), Tsantrizos *et al.* (5,395,496), Tsantrizos *et al.* (5,147,998), Matsumoto *et al.* (JP 07061803) and Cohen *et al.* (5,993,697) are withdrawn in view of a new rejection (See *New grounds of Rejection*) which better addresses the current as amended claims.

Applicant wishes to acknowledge and express appreciation for the two telephone discussions which the Examiner undertook with Applicant's Patent Agent, Joan M. Van Zant, with respect to overcoming the further rejections raised by the Examiner in the current action.

DESCRIPTION OF AMENDMENTS

Applicant has with this amendment, provided amendments to claims 1, 24 and 25. In particular, Applicant has indicated the formulae which may be used to calculate the rapid quenching rate which is a feature of the processor of the present invention. More specifically, the following passage has been inserted into each of claims 1, 24 and 25, as noted:

In paragraph d) of claim 1, paragraph c) of claim 24 and paragraph d) of claim of 25, the following words are now found:

"wherein the plasma stream is rapidly cooled at a quenching rate which can be calculated in accordance with the formula $\Delta T / t$, where ΔT is the temperature difference between the temperature of the plasma entering the nozzle T_2 and the temperature of the plasma in the quenching zone T_1, with the average temperature entering the nozzle T_2 being calculated by the formula $T_2 = T_1 + \frac{W_p}{\dot{m}C_p}$, where T_1 is room temperature; W_p is the energy input to the plasma, $\dot{m}$ is the mass flow rate of the carrier gas; C_p is the specific heat of the carrier gas; and t is the time for the plasma stream to travel from the plasma torch to the quenching zone, where t can be calculated by the formula t = length of nozzle / velocity of plasma gas entering the nozzle,".

As noted by the Examiner in the comments relating to the amendments to the specification, a similar paragraph has been included at appropriate points in amended paragraph [0005] submitted herewith.

This amendment is in keeping with the Examiner's suggestion that the claim be amended to remove the specific temperature, and to insert the formulae relating to the calculations of the quenching rate in the claims and in the description.

In addition to the above insertion, Applicant has also removed the reference to the diameter range of the metal catalyst nanoparticles from the claims and the description.

The Examiner has objected to claim 24 as being a duplicate of claim 1. In Applicant's

opinion, there are patentable differences between claims 1 and 24. One important feature found in claim 24 that is not present in claim 1 or claim 25 is the feature in paragraph a) of the cooled nozzle having a carbon containing substance and carrier gas feed. This is a feature which is found in the example in the description, and Applicant would submit that it is appropriate to include in the claim and to retain the claim, since this provides specific protection for a particular aspect of the process described in the example of the present application. Thus, Applicant believes that claim 24 should be maintained in the application and is not a duplicate of claim 1 and therefore does not violate 37 CFR 1.75.

NEW GROUNDS OF REJECTION

Claim Rejections - 35 USC § 103

Claims 1, 3, 6, 8-12 and 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsantrizos *et al.* (5,395,496), hereafter Tsantrizos #1, in view of Tsantrizos *et al.* (5,147,998), hereafter Tsantrizos #2, Smiljanic *et al.* (*Chem., Phys. Lett.*, 356, 2002-189-193), and Matsumoto et al. (JP 07061803).

Once again and with respect, Applicant goes back to its previous remarks regarding obviousness rejections.

In order to establish a case of obviousness "the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be determined; and the level of ordinary skill in the art resolved. Against this background the obviousness or non-obviousness of the subject matter is determined. [Such secondary factors as commercial success, long felt but unrecognized needs, failures of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented."] *KSR Int'l Co. v. Teleflex Inc., 127 S.Ct. 1727 (2007)*, citing Graham v. John Deere Co., 383 U.S. 1 (1966).

In order to reject a claim based on a combination of references, as explained at **MPEP 2143** (citing the *Supreme Court in KSR v. Teleflex*), "Office personnel must resolve the Graham factual inquiries...

Then, Office personnel must articulate the following:

(1) a finding that the prior art included each element claimed, although not necessarily in a single prior art reference, with the only difference between the claimed invention and the prior art being the lack of actual combination of the elements in a single prior art reference;

(2) a finding that one of ordinary skill in the art could have combined the elements as claimed by known methods, and that in combination, each element merely performs the same function as it does separately;

(3) a finding that one of ordinary skill in the art would have recognized that the results of the combination were predictable; and

(4) whatever additional findings based on the Graham factual inquiries may be necessary, in view of the facts of the case under consideration, to explain a conclusion of obviousness.

KSR, 82 USPQ2d at 1395; Sakraida v. AG Pro, Inc., 425 U.S. 273, 282, 189 USPQ 449, 453 (1976); Anderson's-Black Rock, Inc. v. Pavement Salvage Co., 396 U.S. 57, 62-63, 163 USPQ 673, 675 (1969); Great Atlantic & P. Tea Co. v. Supermarket Equipment Corp., 340 U.S. 147, 152, 87 USPQ 303, 306 (1950). "[I]t can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does." KSR, 82 USPQ2d at 1396.

The Examiner in rejecting claims 1 and 24 based on Tsantrizos #1, indicates that this reference does not teach a cooled nozzle, selecting a metal catalyst and providing it to the plasma stream, and a resultant plasma stream of carbon, carrier gas and metal vapor to generate *in situ* metal catalyst particles which act as nucleation sites for the carbon nanostructures. All of these steps are of course better defined in the present invention as claimed herein. The Examiner then combines these teachings with Tsantrizos #2 which the Examiner indicates more completely describes the same torch as Tsantrizos #1 and further that the teachings of Tsantrizos #2 are directed to a cooling system for cooling the electrode so that it does not overheat and melt.

In Applicant's opinion, it is not possible to achieve the rapid quenching that is found in

the process of the present invention if one follows the teachings of Tsantrizos #1 and Tsantrizos #2 as proposed by the Examiner. Further, the combination does not mention this type of cooling, let alone its benefits, and further that it is part of a heterogeneous process that comprises the present invention.

As Applicant has indicated earlier, the teachings of Tsantrizos #1 relate to the use of a DC thermal plasma torch for the homogenous chemical reaction process to form fullerene molecules (C_{60} and C_{70}) in a plasma environment specifically attempting to maintain a large and uniform temperature environment. There is no teaching in this reference relating to the generation of metal catalyst nanoparticles which act as nucleation points and catalyst for the growth of carbon nanostructures. The present process is a "heterogeneous" process that involves generating the metal catalyst vapor which is then combined with carrier gas and carbon and then subjected to a rapid quenching to generate, on a consistent basis, carbon nanostructures. Tsantrizos #2 talks about cooling the electrode, but does not suggest or intimate the rapid quenching that is provided by the process of the present invention and, in Applicant's view, the advantage of this particular system is not obvious from the teachings of Tsantrizos #2. In addition, it is important to recognize that no one achieved the results achieved by the Applicant until the present process was developed which, in Applicant's opinion, clearly indicates that the teachings of Tsantrizos #2 do not make the present process obvious given that it is the heterogeneous process provided by the present invention that ensures the production of the desired carbon nanotube structures.

As for Smiljanic, this reference does not explicitly teach using a high enthalpy plasma torch with a nozzle to produce the plasma used in carbon nanotube production. Smiljanic discloses the fabrication of single wall carbon nanotubes using a **microwave plasma reactor**, a system operating in the non-thermal plasma region meaning one having different temperatures for electrons (light species) and atoms/molecules (heavy species), coupled to a furnace maintained at 1300°K, and having the carbon (ethylene) and catalyst (vaporized ferrocene) precursors injected in a vapor form in the microwave plasma. The process conditions that are achievable in the present process are not possible in a microwave plasma torch. The teachings of a process using a microwave plasma torch are not transportable to the high enthalpy plasma torch of the present

invention.

In the circumstance, Applicant believes that the Examiner's rejection of the claims based on the combination of these references is unsupportable and cannot be used to reject the claims as the claims clearly distinguish over the teachings of these references. The Examiner makes a number of rejections of claims 3, 6 and 22, 8-10, 23 and 11 and 12. Applicant believes that none of these rejections apply, since the rejections of claims 1, 24 and 25 are unsupported and the rejection of these additional claims cannot stand, given that they are appended to one or more of the referenced independent claims.

CLAIM REJECTIONS - 35 USC § 103(A)

Claims 13 and 14 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Tsantrizos #1, Tsantrizos #2, Smiljanic, and Matsumoto as applied to claim 1 above, and further in view of Cohen *et al.* (5,993,697).

Applicant believes that the rejection of claims 13 and 14 should not stand, since these claims are appended to claim 1. As Applicant has stated, claim 1 is a patentable claim and therefore the rejection of Claims 13 and 14 cannot succeed.

RESPONSE TO AMENDMENT

The Examiner has made comments regarding the declarations, filed with the last response, of Dr. Meunier and Dr. Boulos.

Some clarification of Dr. Meunier's declaration appears to be proper. Firstly, it should be noted that the declaration is focused on the example in the application in terms of providing specific calculations using the formulae which the Examiner has acknowledged are found in the prior art and which allow the determinations proposed in the declaration of Dr. Meunier regarding the rapid quenching rate obtained in the specific example. It should be pointed out the limitations in question are merely the features of the exemplified structure, and not the only possible structure, which was used to conduct the process of the invention. The claim should not be limited to the specific example, since it is quite clear that the teachings of the description as a whole are broad enough to encompass operating outside the specific parameters.

The declaration of Dr. Boulos is not merely opinion, since he has attested to the fact that he has read and understood Dr. Meunier's declaration and he is in agreement with the statements made therein. Given that both of these gentlemen have worked a number of years in the relevant area of technology, it should be clear that their opinions are based on facts, experiments and observations over a long period of time which support their views. Thus, the Applicant would submit that the declarations do support the arguments against the Examiner's rejections and should be accepted.

RESPONSE TO ARGUMENTS

In paragraph 14 of the Examiner's Action, the Examiner has indicated that the language that appears in the claims needs to be found in the specification, and Applicant believes that this is now the case with respect to the formulae which Applicant has referenced form part of the prior art relative to the present application. As a result, Applicant has amended the specification to include the formulae in question, which Applicant understands is acceptable.

In paragraph 15 of the Examiner's Action, the Examiner references the fact that the Tsantrizos #1 and Smiljanic references do not disclose a specific cooling rate above 10^7°C/s due to carbon containing substance and carrier gas. With a view to overcoming the Examiner's rejection, this particular temperature has been removed from the claims but the formulae which are used to calculate this specific temperature have been included in the claims, as well. On this basis, the presence in the claims of these formulae should therefore overcome the Tsantrizos #1 and Smiljanic based rejections.

As for the Examiner's remarks in paragraph 16 of the Examiner's Action relating to the Matsumoto reference, Applicant would note that while there were difficulties in arriving at the present invention, the important aspect that led to success was the appreciation of the benefit of producing the catalyst metal vapor in a plasma torch at very high temperatures which, when combined with carbon and a carrier gas, and then subjected to rapid quenching at a rate described by the formulae found in the amended claims produced the desired carbon nanostructures. This resulted in what is referred to as heterogeneous process which is not described or suggested in any of the cited art, either

alone or in combination.

CONCLUSION

Given that the Examiner has indicated in the last two telephone discussions with the Applicant's Patent Agent, Joan M. Van Zant, that there does appear to be inventive aspects associated with the process of the present invention, and those are related to the heterogeneous environment provided by the process, and this environment is now well defined by the parameters found in the amended claims, Applicant believes that the subject-matter of the claims of this application should be allowable and requests that the Examiner issue a notice of allowance.

Should the Examiner have any questions or require further clarification, please contact the undersigned by telephone.

Respectfully submitted,

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By: _____

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